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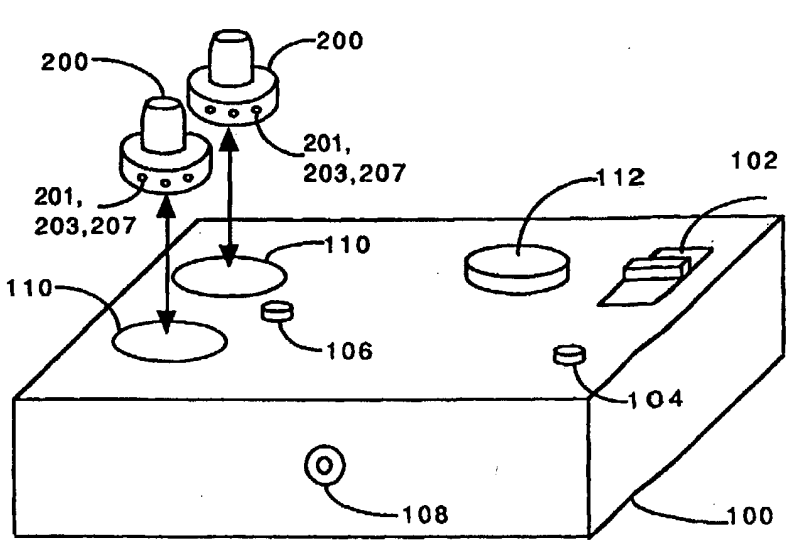

(57) Abstract

A method for establishing a communication link between a transmitter (100) and a receiver (200) for the purpose of relaying audio material derived from an existing source (108) to a user desiring to remain unencumbered by the source apparatus comprises the steps: placing the receiver unit into physical contact with the transmitter unit, powering up both transmitter and receiver units, and waiting for an indication (104, 106) of process completion before setting the receiver unit in place. The transmitter unit searches for a free rf communication channel, initiates transmission of user–chosen audio material over permitted broadcast bands, and programs (110) the receiver unit with information of the ear or on the head in the conventional manner. The entire programming and transmission process takes place automatically with further intervention.

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Personal, Self-Programming, Short-Range Transceiver System

Technical Field

The technical field of the invention is that of a consumer electronics device based on wireless transmission of information. The range of transmissions is purely local (i.e., short distances up to thirty meters, more or less) and designed to provide a personal transmission channel from a nearby audio source such as a tape recorder, record player, compact-disk player, radio set, and so forth. The transmitter and receiver technology operate in the standard radio-frequency bands such as the US 88 Megahertz (MHz) to 108 MHz FM band or in the unregulated low-power bands where standard frequency- and phase-modulation techniques are employed or in the very-low frequency band where pulse-modulation techniques are common.

Background Art

The field of consumer audio electronics comprises a wide variety of personal listening devices—from hand-held and wearable radios and communicators to portable devices for retrieving audio information stored in many forms such as cassette-tape media and compact-disk media of various types. There also exist various earphone devices auxiliary to or integral with many of these personal entertainment devices. The vast majority of these personal listening or entertainment devices require that the sound storage and playback unit, i.e., the sound source that produces an electrical signal in the audio range, be carried along with the user. A majority of these latter devices that are equipped with personal earphone units send an electrical signal from the playback device to the earphone device via a cable or wire, potentially encumbering the user or providing an easily noticed indicator that the user is engaged in some sort of entertainment activity via an audio source. Of course, there are a large number of such commercial devices, ranging from those trade-marked to those fully patent-protected, that are easily recognizable in the marketplace. It is to be noted that the field of such devices, comprising the bulk of the prior art, is too large to enumerate in this document. The following discussion will be restricted to devices that are more clearly and particularly focused in the field of the present invention.

A commonly encountered device is a fully functional FM or AM radio built into a set of wearable headphones. The advantages are complete portability, wearability, and tuneability over the full broadcast bands, including stereo reception for the FM band. For example US patent 4,930,148 describes a headband radiophone containing a receiver-transmitter to reciprocally transmit or receive signals. Another example is furnished by US patent 5,095,382 which describes a wireless headphone designed to reciprocally transmit and receive signals by means of an infrared beam of light.

There are also several types of wireless headphones on the market primarily designed to allow the user to listen to audio sources such as television or a home-music or entertainment center without disturbing others. The wireless nature of said devices allows the user freedom to move

about within the restricted range of the transmissions without being encumbered by wires or cables precisely as in the present invention. These wireless headsets are meant for use in restricted areas usually confined to a few rooms in or near a dwelling and do not provide capacity for a plurality of channels for multiple users. The latter capability is achieved by purchasing multiple units. As each device comes with its own pre-assigned channel, these devices are not suitable for group activities. The present invention would fulfill the stated purposes of these existing devices yet not be burdened with the aforementioned restrictions and limitations. In particular, the present invention allows multiple independent users in the same proximity by means of its self-programming function, and it allows multiple users to share in the same locally broadcast material without requiring multiple base units or transmitters.

Closer to the present invention is US patent 5,677,964, which describes a transmitter-receiver system wherein the transmitter unit is installed in an audio equipment and the receiver unit is installed in an earphone. A goal here is to allow the user to listen to information transmitted from the audio equipment without interfering with others in the vicinity or having exposed wires or cables between the audio equipment and the listener.

An invention likewise close to the present invention in the area of miniaturization by describing a device fitting within the outer canal of the ear, is US patent 5,734,976 which describes a micro-receiver for receiving a high-frequency frequency- or phase-modulated signal and is based on single integrated circuits in BiCMOS technology integrating the necessary amplifiers, oscillators, modulators, demodulators, filters and audio amplifier.

The description of US patent 5,677,964 includes a transmitter partially fulfilling the role of the "base unit" described in the present invention. That of US patent 5,734,976 is primarily concerned with a prosthetic hearing-aid device, yet certainly meets one of the desired goals of the present invention in being small, lightweight, unobtrusive, and capable of being worn in the outer canal of the ear and containing the required receiver circuitry and power supply. Neither of these descriptions considers a base unit that automatically selects the first available frequency band for transmissions, or a base unit that automatically programs the receiver unit to receive transmissions on said frequency band, or a base unit that is functionally as portable as the receiver unit. The second description also implies that the associated transmitter unit is to be worn by the user as necessitated by utility of prosthetic hearing-aid devices. Combining the essential ideas present in these two existing inventions approaches, but does not reach, the functionality and convenience of the proposed invention.

Disclosure of Invention

The idea of the invention is to provide a private and unobtrusive means for a user to listen to a local (nearby) source of music or other audio entertainment or information on a dynamically selected channel that is simple to establish and does not interfere with possibly many other users at the same location. Logically and physically, the invention comprises two distinct modules: (1) a

receiver or earphone and (2) a transmitter or base unit. It is thus the intention of the invention to provide a wireless connection between the earphones and base unit, allowing the user to move freely about, unencumbered by cables or wires, within the limited range of the base unit's transmissions. It is a primary intention of this invention to allow multiple users in the same location either to listen to independent sources of entertainment or information or, if desired, to share such sources with others possessing similar receiver units (earphones). Furthermore, it is the intention of the invention that the receiver unit be small, compact, lightweight, and unobtrusive both visually and kinesthetically.

The first module consists of a lightweight, wireless, radio-frequency receiver or receiver pair (for stereo sources) mounted in lightweight headphone or head set or earphones. "Earphones" in the following description is understood to refer to any convenient ear-external or internal device consistent with the contained receiver units. The earphones may be either externally worn or internally fitted to be placed in the outer canal of the ear, as the user desires. Furthermore, the earphone receiver units are "self-programmed" as described below. This latter feature ensures simplicity of operation and ease of use while maintaining flexibility of multiple devices operating in the same local area while minimizing inter-unit interference.

The second module, the transmitter or base unit, has four functions: (1) to select automatically a clear transmission channel for said transmission, (2) to program or lock the earphones to receive exclusively on said automatically preselected channel, (3) to modulate an appropriate radio frequency on said channel by the chosen audio-level input for low-power transmission to the earphones, and (4) to provide power to the earphones by way of charging their contained batteries. The base unit is likewise small, lightweight, and portable, being just large enough to contain (1) the scanning circuitry, (2) the programming circuitry, (3) the transmitter circuitry, (4) the battery-charging circuitry, (5) minimal controls and indicators, (6) appropriate signal connectors, and (7) a battery or other type of power supply.

In a typical situation, the user switches both the earphones and the base unit to the "on" position as indicated by small light-emitting diode indicators and then inserts the earphones into specially designed receptacles located in the base unit. The power-on action initiates charging of the earphone batteries should they require it. This power-on action also initiates a "scan" function comprising a sequence of events that (1) effectively searches for an "open" channel, (2) locks a frequency synthesizer or phase-locked loop to the frequency of the first open channel thus located, and (3) sends a "lock" command via contacts located in the receptacles to a frequency synthesizer or phase-locked loop in each of the earphones. At the end of this "auto-programming" sequence, (4) a "ready" indicator or signal indicates that the user may now remove the earphones and place them in position for listening, moving about the area as desired, within the limited range of the base-unit's transmitter, receiving the audio information from the source connected to the base unit via the standard process of demodulation, amplification, and presentation of the electrical signal thus obtained to the earphones' electrical-acoustic transducers.

Other users of similar devices located within the same transmission range, or even in overlapping transmission areas of the first device, will not find an open channel at the same frequency chosen by the unit just programmed or any active prior-activated units as well. Any base unit attempting to program its own earphones will scan for the first clear channel, starting at one end of the selected spectrum, ensuring that no user will interfere with any other and no strong, established broadcasts will interfere with a user's auto-selected channel. The number of channels available in any area depends on the broadcast band chosen and the bandwidth (plus guard band) for each device. As an example, assume parameters consistent with the standard US FM broadcast band of 88 to 108 MHz and 100 KHz bands, there would be "room" for perhaps 200 independent users, not accounting for any strong commercial FM broadcasts, which would reduce this number by at least one unit for each such strong station.

If other users of an identical device within the same transmission range wished to listen on a common channel and hence to the same audio source as provided via transmission by any given base unit, they would simply place their compatible earphones into the receptacles of said base unit and depress a secondary "program" or "lock" control button. Such action would lock their earphones to the preselected channel of the chosen unit. In this manner, multiple users can listen to the same source, allowing for class or shared-listening activity.

Due to its compact nature, the earphone electronics are fabricated with surface-mount methods using standard integrated circuits and monolithic lumped components. Discrete components are used in the circuit where necessary to establish externally selected frequency ranges as well as other functions such as passive filters. Both receiver and transmitter units are separately powered, with the receiver earphones having a battery power supply, and the base unit either a battery or other means of power.

The key features of the invention are summarized as its ability to avoid interference with commercial broadcasts due to the auto-scan feature; to be compliant with communication authorities' rules of low power and short range in certain restricted bands; to its "foolproof" use based on minimal controls and no adjustments; to provide wireless operation; to contain rechargeable or replaceable batteries in base unit; to contain rechargeable and/or replaceable batteries in earphones; to restrict the physical dimensions of the base unit into a small, compact, lightweight, and easily transportable and detachable module independent from any particular source of program material; and to provide the user with the earphones that are ultra-light weight and/or fit in outer ear or mounted on a lightweight, supporting frame.

Although the primary conception and purpose of this invention is to provide an auxiliary but extended capability for standard sources of audio material in the sense that any source device having the required "signal" or "audio" output connector with compatible impedance characteristics can be connected to the base unit described in this invention, there are numerous variations possible based on the described invention besides the mentioned uses of transmitting local audio

sources to listeners not wishing to be encumbered by wires or highly visible head pieces. These variations may be differentiated, among other characteristics, by various sources for the transmitted audio material. The preferred embodiment presented herein should in no way restrict the present invention to a particular configuration as regards usage.

A modification of the base unit could be made with a built-in microphone or an input with an impedance-matching amplifier and gain control designed for such a microphone. Such a unit could be used to send verbal messages or any other sound based on sound pressure waves to those with compatible earphones. For example, a type of selective-broadcast communication only to users having completed the "lock" process with the centrally chosen base unit could be established, allowing only those users to receive said communication, even though in a crowd or noisy location.

A modification of the base unit could be made to equip it with a built-in radio receiver allowing the user to select a local radio station for listening remotely from said radio receiver. Otherwise and more generally stated, the standard types of sound reproduction devices could incorporate the invention described here rather than said invention serving said devices as an auxiliary. In which case, the auto-scanning and self-programming functions would be retained as essential to benefit from the innovations described herein.

Brief Description of Drawings

FIG. 1 depicts a particular representation of the base units and illustrates how the earphones fit into the provided receptacles.

FIG. 2 is a block diagram of a typical application illustrating the logical relation of the audio source, base unit, earphones, and the user following programming by the base unit.

FIG. 3 is a functional block diagram of the base unit showing the logical relationships between the three functional modules of scanner, transmitter, and programmer.

FIG. 4 shows details of the functional modules comprising the base unit depicted in FIG. 3.

FIG. 5 is a functional block diagram of one of the earphones; the other is identical except that it receives the alternate stereo channel when applicable.

Best Mode for Carrying Out the Invention

A transmitter-receiver system in accordance with the present invention is comprised of a transmitter unit (the "base unit") that is either a separate module connected to an audio source by means of a cable or suitable connector or integral to such a source, and a receiver unit installed in an earphone or earphone pair ("earphones"). The inventive arrangements are directed to methods and apparatuses for establishing a clear channel for the desired transmission and for locking the receiver units to said clear channel, ensuring that said transmitter and receiver units function together as an integrated system. Secondary goals of lightweight and unobtrusive earphones, the

maintenance of sufficient energy for the earphones, and wireless communications that includes modulation, demodulation, methods of maintaining frequency stability, amplification of rf and audio signals, and driving appropriate electro-acoustic transducers are accomplished by incorporating features and devices that are well known to those familiar in the art.

The present invention has been accomplished to provide a transmitter-receiver system which eliminates the aforesaid problems and simultaneously meets the particular objectives of effecting a private and unobtrusive means of listening to a nearby source of information, said means being simple to use yet having minimal interference with other users of the same rf band in the same local area. To this end, a wireless rf link between a self-programming, transmitting base unit, and a receiver mounted in small, lightweight earphones are described in detail. A particular preferred means for effecting these goals is presented, along with obvious and useful variations that extend the preferred means in several nonessential ways.

A power source, typically a battery, together with its necessary connections to each of the functional modules and devices depicted is to be understood to be functionally present in all of the figures, as is a suitable return path (earth or ground) for returning current to the power source, thus completing the circuits as required.

Referring now to the drawings wherein like numbers refer to like parts, FIG. 1 is a conceptual view showing the relationship between the base unit **100** and the earphones **200** before and after the programming operation and schematically indicating the process of such programming. Other configurations are possible, so the illustration of this particular configuration is not to be restrictive for implementation or use of the invention. A particular placement of the controls comprising power switch **102**, indicator lights **104** and **106**, and audio-input connector **108** are also shown. Control **112** allows manual programming of the earphones **200** once the programming operation is complete as indicated by indicator light **104** changing state from flashing to steady. The arrows indicate the process of inserting and removing the earphones **200** from their programming receptacles **110** in base unit **100**. Contacts **201**, **203**, and **207**, located on earphones **200**, have mating contacts (not shown) in base unit **100** and allow communications necessary for the programming activity to take place between these two functional modules.

FIG. 2 is a block diagram showing the unified operation of the earphones **200** and the base unit **100**. The earphones **200** have already been programmed by the scanning function of the base unit **100** and are shown receiving the rf signal modulated by the audio source, which may be any of a plurality of readily available devices such as tape players, compact-disk players, and so forth. The presence of the user is indicated by a sketch of a head in the figure.

FIG. 3 is a block diagram of base unit **100** of FIG. 1. The operation of this unit is described in functional order starting with activation of the power-on switch **102**, which supplies power from battery **118** to all associated electronics via line **111**, resets all circuits and logic in base unit **100** to a standard initial state, initiates the scanning and programming sequences, and causes the

"scan" indicator light **104** to flash, indicating that the scanning sequence is in progress and that the unit has power. The function of the three submodules are described here, while details are deferred to a subsequent figure.

The scanner **120** comprises a scan controller **130**, a channel detector **150**, a shared frequency synthesizer **170**, a transmit-receive switch **122** and indicator lights **104** and **106**. Upon power-on, the scan controller **130** examines the state of the earphones **200** via line **113**; if not turned on before insertion into receptacles (**110** of FIG. 1), warning light **106** is illuminated indicating a procedural error to be corrected. The latter criterion being met or the error corrected, the scan controller **130** signals the programmer **190** via line **117** and starts a frequency-sweep sequence, sending coded information to the frequency synthesizer **170** via line **119**, controlling the frequency-scanning sequence. The channel detector **150** receives the synthesized frequency (local oscillator frequency) from line **121** via the switch **122**, which is set to connect the frequency synthesizer **170** to the channel detector **150** during the initialization sequence. The channel detector **150** then examines the signal from the antenna **114** via line **115** which signal is heterodyned with the synthesized frequency entrant on line **121** in a manner familiar to those skilled in the art. The transmit-receive switch **116** is likewise configured to connect the antenna to the channel detector **150** during the initialization sequence. The function of the channel detector **150** is to locate a frequency subband where there is little or no carrier present. Such a subband being located, the channel detector **150** signals the scan controller **130** via line **123**, whereupon scan controller **130** stops commanding the frequency synthesizer **170** to advance, sends a signal to the programmer **190** via line **125**, changes the state of indicator light "scan" **104** from flashing to continuously on, indicating that the user may proceed to the next stage. Additionally, switches **116** and **122** are set to the alternate or "transmit" state via signals (not shown) from the scan controller **130**.

The programmer **190** comprises a battery charger **192** and a one-shot circuit **194**. Details concerning the action of the battery charger **192** are known to those familiar with the art and are not elaborated upon here. Upon receiving a start signal via line **117**, the battery charger examines the voltage level on each of the batteries in the earphones **200** (FIG. 1) and supplies any current needed to charge them to the operational point, said charging operation taking place during the scan sequence; the charging current is presented to the earphones via line **127** through contact **103**. Contact **107** made to each earphone via connector block or receptacle **110** transmits an enabling level from oneshot **194** via line **129**. Those skilled in the art recognize that oneshot **194** can be made to emit a logic pulse of predetermined duration given a leading- or trailing-edge trigger input as may be applied by the scan controller **130** upon completion of its scan process or at the discretion of the user via external control **112** via line **109**. Contact **101** in connector block **110** receives a sample of the frequency of the located rf subband via line **124**. Contact **105** in connector block **110** provides a common ground to the earphones.

The transmitter **160** comprises the shared frequency synthesizer **170**, a modulator **180**, and an rf amplifier **162**. At the end of the scan cycle as indicated by signals from the scan controller **130**, the switch **122** is configured so that the signal from frequency synthesizer **170** is applied as the carrier frequency to the modulator **180**. The details of the phase and frequency modulation as performed by modulator **180** are well known to those skilled in the art and need not be described in detail. The audio-in signal via connector **108** is used to modulate said carrier frequency, whence the modulated carrier is amplified as necessary by rf amplifier **162** and allowed to reach antenna **114** through switch **116**, which has changed state via a signal (not shown) from scan controller **130**.

FIG. 4a shows the details of the scan controller **130**. Upon receiving power via line **111** from the power-on switch (**102** FIG. 3), AND gate **134** senses the state of the unit's power. The state of earphones **200** (FIG. 1) is sensed via line **113** by comparator **136** whose output, indicating "on" state for the earphones **200** (FIG. 1), is also applied to AND gate **134**. Reference **132** in an internally set parameter chosen according to design parameters. The complementary state of the comparator **136** is sent to buffer amplifier **138** which connects to "fault" indicator light **106** should the earphones **200** (FIG. 1) be in the power-off state. The AND gate **134** passes the "start" logic level obtained from the power line via line **111** when power is on in both the base unit **100** (FIG. 1) and earphones **200** (FIG. 1). Power-on switch **102** (FIG. 3), via line **111**, also applies power (via the V_{CC} connections common to all modules) to multivibrator **140** to send a flashing signal to buffer **142** and thence to indicator light **104** indicating that a scan is in progress. The logic level from AND gate **134** triggers oneshot **144** which emits a logic pulse or level of duration of approximately 1 second, predetermined by the time-constant capacitor (not shown). This level is applied to integrator **146** and thence to sample-and-follow **148**. The output of sample-and-follow **148** follows the input from the integrator **146** until it receives a "sample" command. Said output is sent to the frequency synthesizer **170** (FIG. 3) via line **119**. Once a clear channel is located as determined by the channel detector **150** (FIG. 3), line **123** is activated by said channel detector. A high logic level on line **129**, buffered by amplifier **149**, causes sample-and-follow **148** to sample and transfer a digitally coded version of its input voltage to its internal digital memory, effectively maintaining said voltage level for subsequent presentation to the frequency synthesizer **170** (FIG. 3). The particular details of how said sample-and-follow accomplishes its function are known to those familiar with the art. Said logic level on line **129** also halts multivibrator **140**, leaving it in a "high" state so that indicator light **104** is now steadily illuminated indicating an end to the scan process and communicating the "ready" state to the user.

Referring now to FIG. 4b, which depicts the details of the channel detector **150**, an rf signal from the antenna **114** (FIG. 3) enters via line **115** and is filtered in band-pass filter **151** which is set broad enough to encompass the frequency band of interest over which the transmitted information might appear, depending on the particular operating band pre-chosen for the device. Said signal thence passing to rf amplifier **152** and to mixer **154** wherein said antenna signal is

heterodyned with the frequency signal from frequency synthesizer **170** (FIG. 3) via line **126** after being buffered by amplifier **153**. The heterodyned signal, now at baseband of the frequency from said frequency synthesizer, is passed through low-pass filter **155**. Filtered by integrator **157** to remove ripples, the slowly varying, nearly DC signal is presented to comparator **158**. Said comparator compares the input signal to a preset voltage reference level **159**. When said signal falls below a said reference value, the comparator communicates this information as a voltage level via line **123**.

FIG. 4c shows the details of the frequency synthesizer **170** which comprises a voltage-controlled oscillator **172** and a band-pass filter **174** in this embodiment. Line **119** conveys the ramp signal produced by integrator **146** (FIG. 4a) via sample-and-follow **148** (FIG. 4a), causing the voltage-controlled oscillator **172** to slowly increase its frequency from the lower end of the preselected frequency band to the upper end of said band. Said increase in frequency is presented to the channel detector **150** via lines **121** and **126** (FIG. 3) causing said channel detector to scan the frequency band of interest until the input to said voltage-controlled oscillator no longer changes.

A block diagram of the earphone circuitry **200** is shown in FIG. 5. Said circuitry comprises a complete rf receiver system **220**, that receives its signal to be selected and demodulated in the manner known to those familiar with the art, via line **209**. In the programming mode, which is controlled by the scan controller **130** (FIG. 3) via contact **207**, the transmit-receive switch **210** connects contact **201** to the said receiver via line **209**. Said transmit-receive switch is placed in the aforementioned position by powering up said earphones by closing switch **204**, which allows the internal battery **206** to be connected to the V_{CC} line that powers all modules present in said earphones. Once the base unit **100** (FIG. 1) has selected an appropriate frequency for transmissions, input to latch **208** rises via contact **207** having received a voltage level from one-shot **194** (FIG. 3) in programmer **190** (FIG. 3) via line **129** (FIG. 3). The falling edge of said voltage level triggers latch **208** which commands switch **210** to disconnect line from contact **201** and connect antenna **214** to receiver **220** via line **209**. At this point, the receiver is receiving and decoding the transmitted material encoded by the transmitter **160** (FIG. 3). The decoded audio signal is presented to audio amplifier **212** via line **211**. Receiver **220** also produces an automatic gain control signal in a manner familiar to those skilled in the art, presenting said signal via line **213** to said audio amplifier for the purpose of controlling the gain of said amplifier should the signal at the antenna **214** weaken or strengthen due to the user moving too far from or too close to the base unit **100** (FIG. 1). Following amplification, the decoded audio signal is converted to sound-pressure waves by the electro-acoustic transducer **215**, whereupon the user may listen to said audio signal while moving about the area.

In the preferred embodiment, receiver **220** is a simple phase-locked loop (PLL) well known to those skilled in the art. Said PLL is augmented in a manner likewise well known to provide a signal proportional to the strength of said carrier frequency for use as an automatic gain control in

addition to the demodulated frequency- or phase-modulated carrier that is subsequently amplified and converted to the desired acoustic signal. The operation of said receiver as regards the particulars of the present invention is described in the paragraph above.

An alternate configuration that is more reliable in frequency locking and holding, but requires additional circuitry, is briefly described here. The alternate method relies on digital synthesis of frequency in the base unit **100** and communication of a digital code for said frequency to the earphones **200**. This is accomplished by modifying the scan controller **130** as follows. Replace oneshot **144**, integrator **146**, and sample-and-hold **148** by an oscillator running at a rate of approximately 256 Hz and a monostable to produce a train of pulses that are presented to digital frequency synthesizer **170** via line **119**. Upon receiving a pulse, said frequency synthesizer advances by approximately 50 KHz more or less, presenting said frequency to the channel detector **150**, which functions as above. Upon selection of a suitable frequency band, channel detector **150** signals scan controller **130** as above via line **123**. Said signal halts said oscillator, effectively maintaining the current digital count held by the digital frequency synthesizer **170**. Said digital frequency synthesizer is then clocked by a signal from scan controller **130** via a line not shown to command said digital frequency synthesizer to present the coded word locked in its internal scalar/counter as a parallel 8-bit digital word to a parallel-to-serial converter in the scan controller **130**. The serial code is subsequently sent to contact **101** during the logic level strobe from said scan controller via line **129**. On the earphone side, via contact **201**, the serial code is converted to a parallel digital 8-bit word by a serial-to-parallel converter (not shown) and read into the digital frequency synthesizer (not shown) contained as a part of receiver **220** of said earphones **200**.

Industrial Applicability

The present invention is aimed at the consumer entertainment area where individual users desire privacy or wish not to disturb near-by persons, desire freedom from constricting and unsightly wires, and desire to be unencumbered by a the source of sound entertainment or information attached to their person. The invention is useful to anyone already in possession of a primary sound source exemplified by but not restricted to a cassette tape player, a commercial-band fm or am radio, a compact-disk player, a television set, or any form of local sound monitor incorporating a microphone or other means of producing electro-acoustic information or entertainment. As an add-on or auxiliary device to be used in conjunction with the aforementioned sound sources, possession of a device based on the present invention becomes a desirable goal. As a system incorporated into presently available primary sources of entertainment or information such as listed above by way of example, the present invention would materially extend the capability of such primary sources and hence increase the usefulness of said sources beyond that of said sources not incorporating the present invention.

Additionally, group activities such as museum tours wherein each group member's earphones are tuned to the same base unit would also be an appropriate and desirable application.

There are specialized systems currently available that meet this requirement, but once manufactured as a consumer entertainment device, adaptation of the present invention to group usage would be much more cost effective than such presently available systems. This group-usage functionality is incorporated into the present invention by intention of design as described above.

By a simple modification, the receiver unit can be made to present its audio signal to a connector rather than to acoustic transducers. Such signal being available as a source of information for self-powered speakers containing appropriate audio amplifiers. This modification allows, for example, a remote, indoor sound source to service outdoor speakers, while maintaining the convenience of automatic channel selection.

Claims

What is claimed is:

1. A receiver unit or system comprising:

a means for receiving and demodulating frequency-, phase-, pulse-, or amplitude-modulated rf information;

a means for decoding said information to baseband to recover the encoded audio signal;

a method of generating and maintaining a local heterodyne frequency to accomplish said decoding;

a method of selecting the source of rf input signal from either of two sources, said sources being an rf signal at from the integral antenna or from an included input connector or contact;

a means for converting said audio signal to an acoustic transducer;

a means for incorporating the acoustic transducer within a earphone housing; and

a means for supplying necessary power to all circuitry.

2. A base unit or transmitter system comprising:

a means for modulating a preselected rf carrier frequency by an audio input signal, said means being either phase, frequency, pulse, or amplitude modulation;

a means for transmitting said modulated carrier;

a method of selecting said carrier frequency;

a means for generating said carrier frequency by means of a frequency synthesizer;

a means for monitoring and charging the earphone batteries of claim 1; and

a method of establishing the local heterodyne frequency of claim 1.

3. The method of claim 2, wherein said selection method subdivides the frequency band into a plurality of bands, one of which, sufficiently free of interference, is chosen for transmission by the apparatus of claim 2.

4. An apparatus of claim 3 wherein said subdivision is accomplished by a swept, voltage-controlled oscillator, said sweep lasting a predetermined duration or until such time as a suitable channel has been located.

5. An apparatus of claim 3 wherein said subdivision is accomplished by a digital frequency synthesizer commanded by incrementing a digital counter integral to said digital frequency synthesizer, said counter being incremented until a suitable channel has been located.

6. An apparatus of claim 3 wherein said frequency band is chosen based on the signal level present in a particular bandwidth range said bandwidth range being selected by the method of claim 3, the selected frequency being applied to a mixer that mixes said selected frequency with the

signal received by the antenna of the apparatus of claim 2. The output of said mixer being filtered and compared to a predetermined level. The criterion for selection of said frequency band being that said output be lower than said predetermined level.

7. A method of commanding or programming the apparatus of claim 1 to cause said apparatus to start receiving on the frequency band selected by the apparatus of claim 2.

8. An apparatus of claim 7 for causing a command signal from the apparatus of claim 2 to the apparatus of claim 1 and information describing the carrier frequency from the apparatus of claim 2 to the apparatus of claim 1 by means of a common contacts between said apparatuses, said command signal being a logic level and said descriptive information being a sample of the output of the carrier frequency generated by the frequency synthesizer of claim 2.

9. An apparatus of claim 8, said command signal being a logic level of sufficient duration and said descriptive information being a binary code describing said carrier frequency, the length of said descriptive information presented to the apparatus of claim 1 being determined by the duration of said logic level.

10. A method of claim 9 wherein the length of said descriptive information is determined by the trailing edge of said command signal logic level.

11. An apparatus of claim 1 wherein said local heterodyne frequency is maintained by a phase-locked loop subsequent to transmission from the apparatus of claim 2 established by the command level of claim 8.

12. An apparatus of claim 1 wherein said local heterodyne frequency is maintained by a digitally controlled frequency synthesizer that receives its code from the apparatus of claim 9.

13. A method of claim 2 wherein any apparatus of claim 1 may be frequency locked to any representative apparatus of claim 2 once said apparatus is transmitting.

14. The apparatus of claim 1, wherein said electronics are manufactured with surface-mount technologies using monolithic integrated, discrete-component circuits, effecting a micro-receiver suitable for miniature earphones.

15. The apparatus of claim 2, wherein said audio source is contained within the apparatus of claim 2 rather than being an auxiliary or external source.

16 The apparatus of claim 15, wherein said contained audio source is a microphone with associated level control components.

17. The apparatus of claim 2, wherein said apparatus is incorporated into or contained within other electronics devices that provide source material for transmission.

18. An apparatus of claim 1, wherein said electronics are digital in nature, making use of any of the common digital methods of demodulation and decoding as customary in spread-spectrum

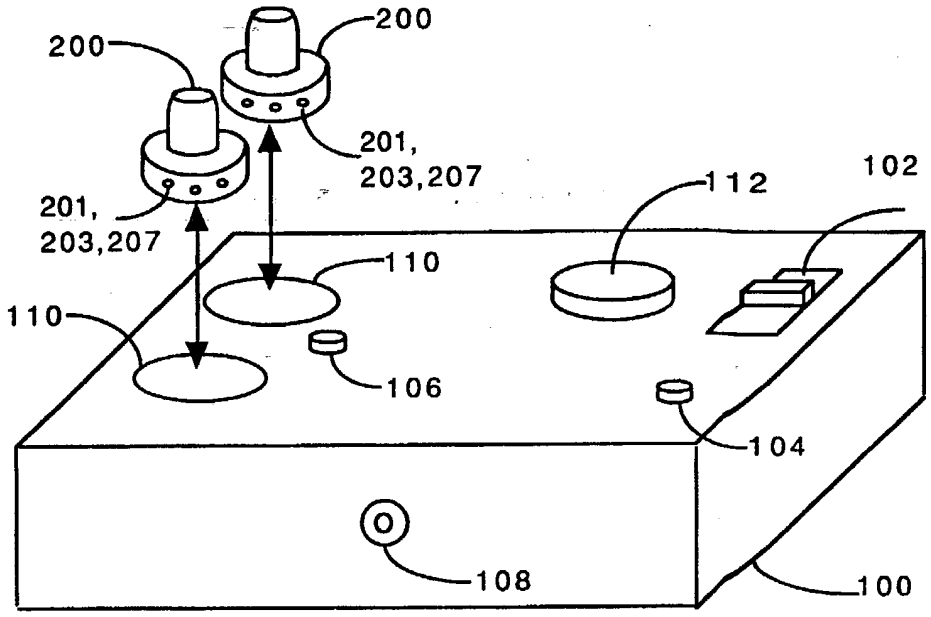
devices, said methods being any of time-division multiple access, code-division multiple access, or frequency-division multiple access.

19. An apparatus of claim 2, wherein said electronics are digital in nature, making use of any of the common digital methods of modulation and encoding as customary in spread-spectrum devices, said methods being any of time-division multiple access, code-division multiple access, or frequency-division multiple access.

20. The apparatus of claim 1, wherein said earphones are mounted externally to the ear and either attached to the ear by independent loop contrivances or attached together with said attachment wire or frame being worn over the head in the usual manner of earphones.

21. An apparatus of claim 1, wherein said receiver unit presents its demodulated audio signal to a connector rather than to an acoustic transducer, making said audio signal available for use by other electro-acoustic devices.

FIG. 1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200
201,
203,207
201,
203,207
112
102
110
110
106
104
108
100

FIG. 2

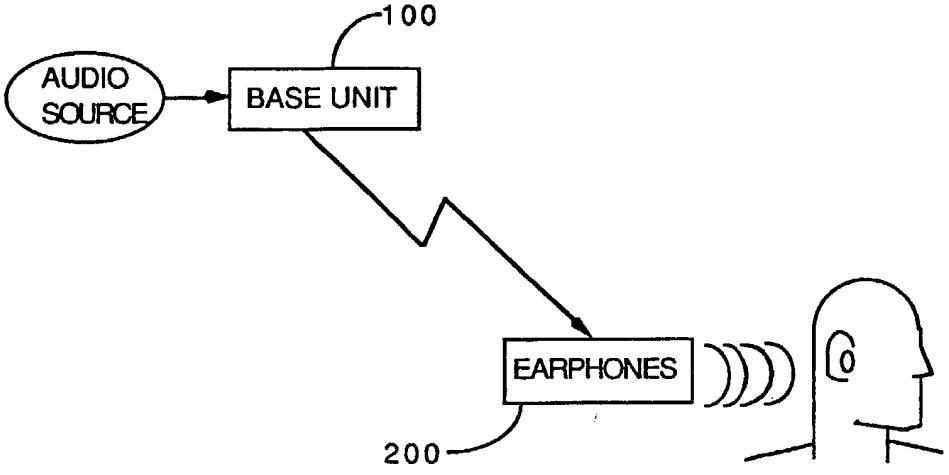
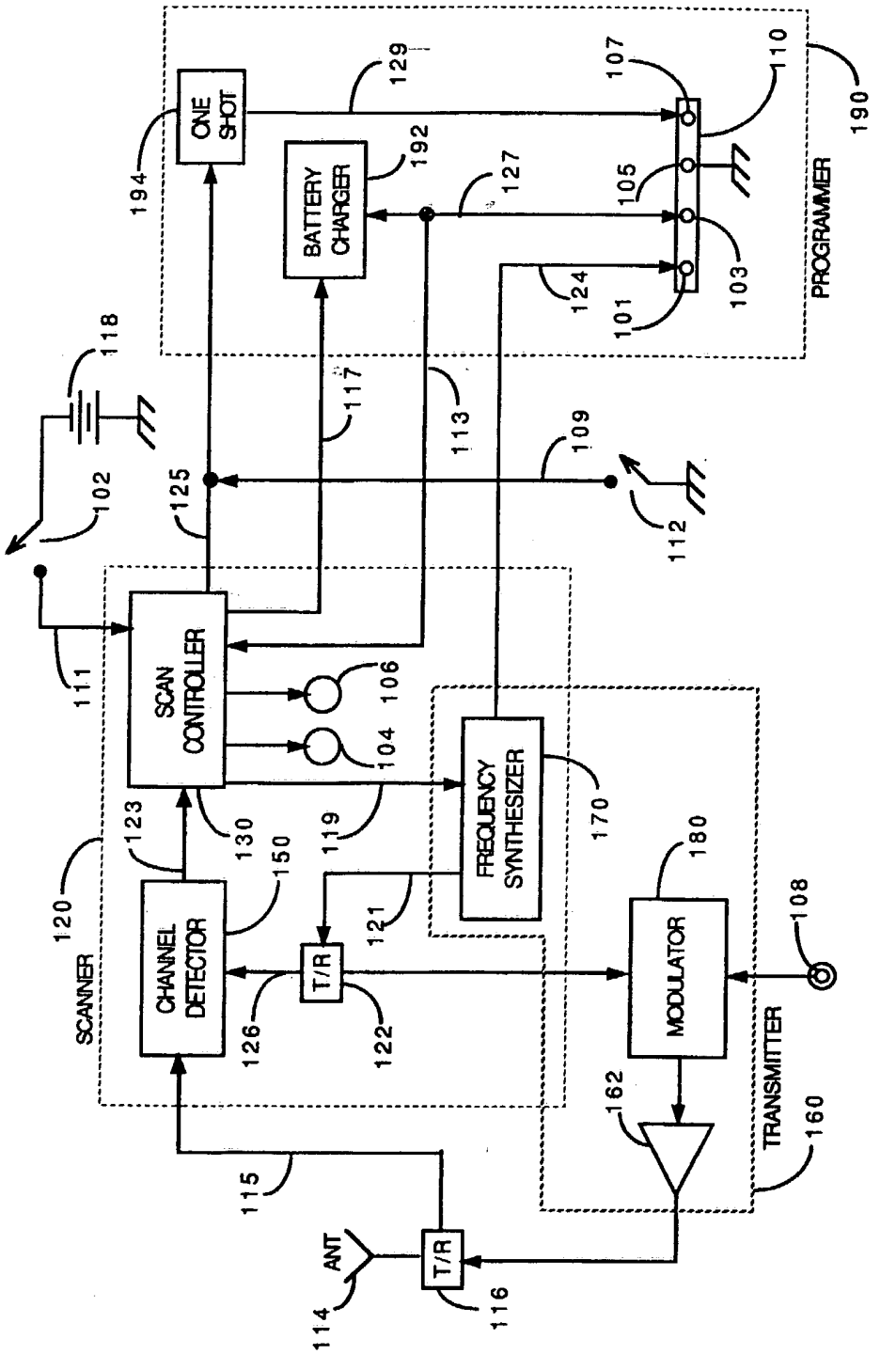

100
AUDIO SOURCE
BASE UNIT
EARPHONES
200

FIG. 3


ONE SHOT
BATTERY CHARGER
PROGRAMMER
SCAN CONTROLLER
FREQUENCY SYNTHESIZER
CHANNEL DETECTOR
T/R
MODULATOR
SCANNER
TRANSMITTER
ANT
T/R
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104
106
107
109
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120
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194

FIG. 4a

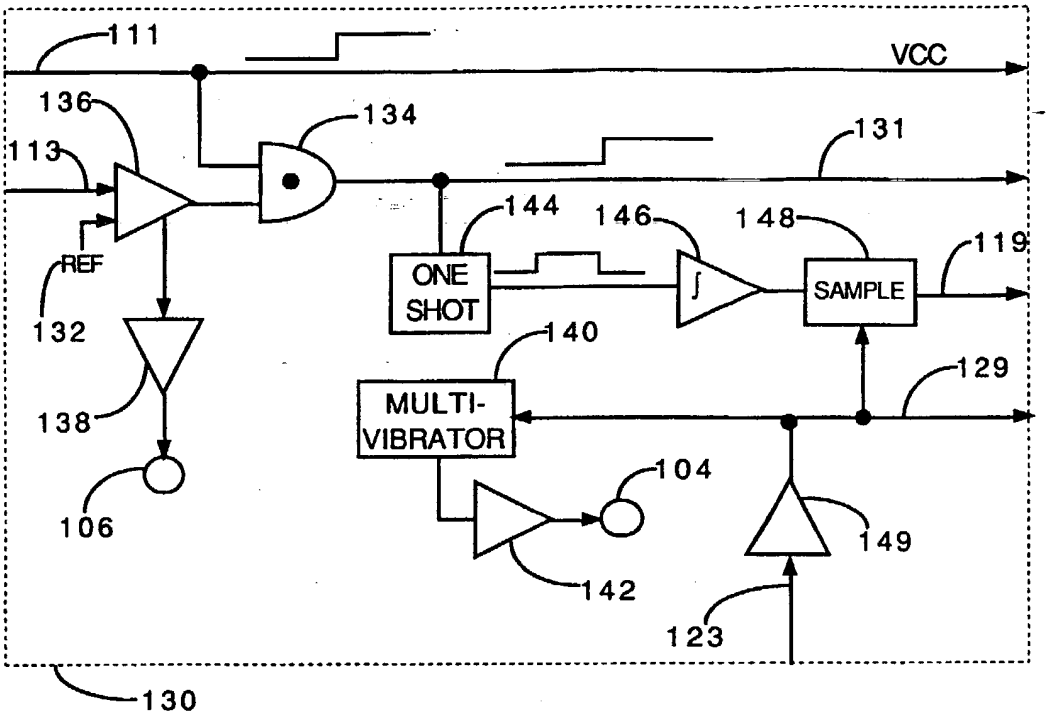


FIG. 4b

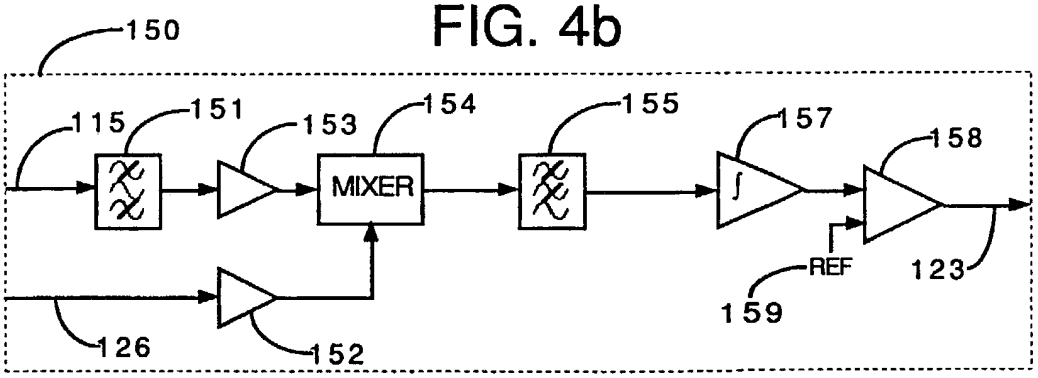


FIG. 4c

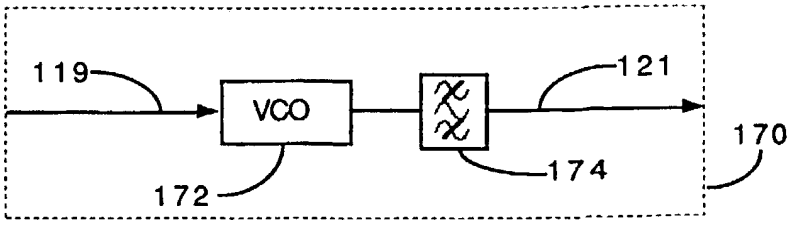
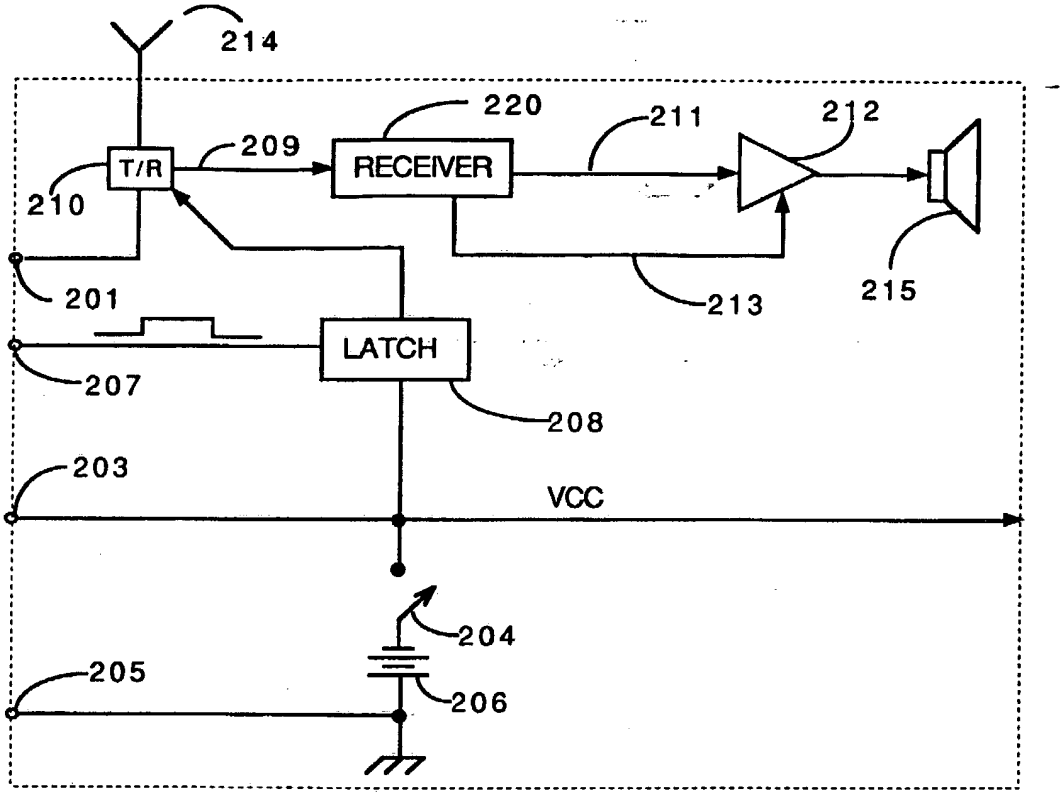


FIG. 5


214
220
211
212
209
T/R
RECEIVER
210
201
213
215
LATCH
207
208
203
VCC
204
205
206

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/20531

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H04B 7/00, 1/38, 1/06, 5/00; H04R 27/00, 25/00, 5/00
US CL : 455/66, 344, 403, 568; 381/82, 79, 68.6, 68.2, 25
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/66, 344, 403, 568; 381/82, 79, 68.6, 68.2, 25

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,815,579 A (BOYDEN) 29 September 1998, col. 4, line 6 - col. 6, ln 36.	1-21
Y	US 5,721,783 A (ANDERSON) 24 February 1998, col. 4, ln 26 - col 15, line 11.	1-21
Y	US 5,619,582 A (OLTMAN et al) 08 April 1997, col. 6, ln 24 - 54; col. 7, ln 28-65.	1-21
A	US 5,771,441 (ALTSTATT) 23 June 1998, abstract; figure 3 and 4.	1-21
A	US 5,794,163 A (PATERSON et al) 11 August 1998, col. 2- col. 11.	1-21
A	US 5,617,477 A (BOYDEN) 01 April 1997, abstract, col. 7, line 40 - col. 9, line 30.	1-21

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 FEBRUARY 1999	16 JUN 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DWAYNE BOST Telephone No. (703) 305-4778

Joni Hill

Form PCT/ISA/210 (second sheet)(July 1992)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/20531

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,276,740 A (INANAGA et al) 04 January 1994, abstact, col. 3, ln 30 - col. 6.	1-21
A	US 5,247,293 A (NAKAGAWA) 21 September 1993, col. 3, line 4 - col. 5, line 29.	1-21
A	US 4,845,751 A (SCHWAB) 04 July 1989, col. 2 - col. 3.	1-21